UNIVERSITY OF CALIFORNIA

GRADUATE DIVISION

PROGRAMME OF THE FINAL PUBLIC EXAMINATION FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

OF

E. RAYMOND HALL

A.B. (University of Kansas) 1924

M.A. (University of California) 1925

TUESDAY, MAY 8, 1928, AT 9:00 A.M., IN ROOM 9

MUSEUM OF VERTEBRATE ZOOLOGY

SUB-COMMITTEE IN CHARGE:

Professor JOSEPH GRINNELL, *Chairman*,

Assistant Professor CHARLES LEWIS CAMP,

Associate Professor BRUCE LAWRENCE CLARK,

Professor WILLIAM BRODBECK HERMS,

Professor CHARLES ATWOOD KOFOID,

Professor WILLIAM DILLER MATTHEW.

BIOGRAPHICAL

1902 —Born in Imes, Franklin County, Kansas.

1924 —A.B., University of Kansas.

1924 (Summer)—Field Assistant, Division of Food-habits Research, Bureau of Biological Survey, United States Department of Agriculture. In Nevada.

1925 —M.A., University of California.

1925 (Summer)—Field Assistant, Division of Biological Investigations, Bureau of Biological Survey, United States Department of Agriculture. In Arizona.

1924–1925—Teaching Fellow in Zoology, University of California.

1926 (Summer)—Assistant, Bureau of Education and Research, California Fish and Game Commission.

1926–1927—Research Assistant, California Museum of Vertebrate Zoology, University of California.

1927–1928—Curator of Mammals, California Museum of Vertebrate Zoology, University of California.

THESIS

Distribution and Speciation in American Weasels (Subgenus *Mustela*)

True weasels (subgenus *Mustela*) form a natural group systematically that has a larger range in America than any other group of mammals of equal homogeneity. Only four species occur in America, each of which shows much geographic variation. Therefore, this group offers an unusual opportunity for noting correlations between structural modifications on the one hand and climatic conditions and geographic position on the other.

Despite the variation mentioned, weasels are remarkably uniform relatively to other groups. Sexual dimorphism is greater than in any other group of the Fissipedia. Variation due to age is great in amount and difficult to determine because all sutures in the skull are obliterated at an early age. For these reasons the group has long been troublesome to systematists and little cited by students of geographic distribution. By assembling material from practically all North American museums, and from some museums abroad, it has been possible to bring the group into a more satisfactory state.

The number of full species is reduced by the present study from thirty-three to four. The number of subspecies is increased from fifty-one to seventy.

Within a single species, geographic variation is of two kinds: first, that expressed in a general trend for a long distance in a given direction; second, that of inconstant trend in any one direction. All parts studied, of the animal, vary geographically. Deep-seated structures, for instance the auditory bullae and the brain case, in contour, vary more than other parts of the skull seemingly in more *direct* contact with the animals' environments.

Weasels comprise an old group. Yet few fossils are known. Species now living occurred in the Middle Pleistocene, but the geographic ranges were not, in all cases, the same as now. The full species form a progressive series, structurally and geographically.

Presence and absence of water are the most important factors determining distribution. Temperature has no appreciable effect in this regard. Changes in temperature and amount of moisture, individually and collectively, are so closely and constantly correlated with several structural variations as to suggest causal relations.

Evidence is furnished as to the tenability, for weasels, of several theories of species forming. Jaeckel's metakinesis seems less applicable than the assumption that some species have progressed farther than others and that ontogeny recapitulates phylogeny. The theory known as "Age and Area" applies only partially to weasels because of the action of other modifying factors. Isolation, *per se*, has had little, if any, effect in producing variations. Natural selection seems not to determine several characters that bear a causal relation to climate. It is not clear that mutation has been a factor of speciation in weasels. Orthogenesis is untenable as regards weasels. Place of origin and manner of distribution of weasels are strikingly in accord with the ideas set forth in the thesis of Matthew's "Climate and Evolution." There is strong indication that species of weasels have been formed by gradual and slow change; also, that particular features of environment actually compel variations that differentiate subspecies and that characterize full species.

GRADUATE STUDIES

Major Subject: ZOOLOGY.

Research in Zoology. Professor J. Grinnell.
Seminar in Zoology. Professor J. Grinnell.
Myology: Vertebrate Evolution. Professor C. L. Camp.
Genetics: Eugenics. Professor S. J. Holmes.
Invertebrate Zoology. Professor Tage Skogsberg, Hopkins Marine Biological Station.

Minor Subject: PALEONTOLOGY.

Research in Vertebrate Paleontology. Professor C. Stock.
Seminar in Vertebrate Paleontology. Professor C. Stock.
Invertebrate Paleontology. Dr. H. G. Schenck.

PUBLICATIONS (PARTIAL LIST)

Occurrence of the Hoary Bat at Lawrence, Kansas. *Jour. Mammalogy* 4:192–193, 1923.

Pelicans versus Fishes in Pyramid Lake. *Condor* 27:147–160, 1925.

A New Subspecies of the California Spotted Skunk (*Spilogale phenax* Merriam). *Jour. Mammalogy* 7:53–56, 1926.

Changes during Growth in the Skull of the Rodent *Otospermophilus grammurus* beecheyi. *Univ. Calif. Publ. Zool.* 21:355–404, 43 figs. in text, 1926.

Notes on Water Birds Nesting at Pyramid Lake, Nevada. *Condor* 28:87–91, 1926.

A New Marten from the Pleistocene Cave Deposits of California. *Jour. Mammalogy* 7:127–130, 1 pl., 1926.

The Abdominal Skin Gland of Martes. *Jour. Mammalogy* 7:227–229, 1926.

Economic Value of Mexican Free-tailed Bat. *Calif. Fish and Game* 12: 135–137, 1926.

Forage Habits of Pocket Gopher. *Calif. Fish and Game* 12:152, 1926.

Systematic Notes on the Subspecies of *Bassariscus astutus,* with Description of One New Form from California. *Univ. Calif. Publ. Zool.* 30: 39–50, pls. 2 and 3, 1926.

The Muscular Anatomy of Three Mustelid Mammals, Mephitis, Spilogale and Martes. *Univ. Calif. Publ. Zool.* 30:7–38, 5 figs. in text, 1926.

An Outbreak of House Mice in Kern County, California. *Univ. Calif. Publ. Zool.* 30:189–203, 1927.

Species of the Mammalian Subfamily Bassariscinae. *Univ. Calif. Publ. Bull. Dept. Geol. Sci.* 16:435–448, pl. 64, 2 figs. in text, 1927.

The Muscular Anatomy of the American Badger (*Taxidea taxus*). *Univ. Calif. Publ. Zool.* 30:205–219, 2 figs. in text, 1927.

The Deer of California. *Calif. Fish and Game* 13:233–259, text-figs. 49–52, 1927.

A Commensal Relation of the California Quail with the California Ground Squirrel. *Condor* 29:271, 1927.

The Barn Owl in its Relation to the Rodent Population at Berkeley, California. *Condor* 29:274–275, 1927.

A New Weasel from Louisiana. *Proc. Biol. Soc. Wash.* 40:193–194, 1927.

A New Race of Black Bear from Vancouver Island, British Columbia, with Remarks on Other Northwest Coast Forms of Euarctos. *Univ. Calif. Publ. Zool.* 30:231–242, pls. 12, 13, 1928.

Records of Supernumerary Teeth in Bears. *Univ. Calif. Publ. Zool.* 30: 243–250, pls. 14, 15, 1928.

Preliminary Examination for Ph. D.
E. Raymond Hall
October 29, 1926

No. 1: Prof. Chester Stock, Dept. Geol., Div. Paleo

What are the most significant features of the palaeontological record of Western North America (ie west of the Wasatch?
What are the provinces in this region?
How do they differ?
Contrast West coast and Great Basin deposits.
How is the age of a formation determined?
When can one use identity of species as a determiner of age?
When can one use the percentage method as a determiner of age?
Discuss stratigraphic determinations. Name all methods used in determining age of deposits. (Discussion of homotaxis and synchrony here also).
What is the age of Reptiles? Are reptiles as important as mammals in showing the modes of organic descent and development? Why not? What reptile groups (fossil) are found in Western America. Where is each found?
What is the thesis of Matthew's essay "Climate and Evolution"? Cite evidence in support of ? . Does the fossil record for the Mustelidae and Procyonidae bear this out. Where are primitive forms found at present? What one (insectivor) is found also on Madascar? Of what groups in addition to horses, camels do we have a fairly complete record? What are the divisions of the Canidae? Where is Amphecyon found. From what form do the Simocyinae and Caninae develop? Does the fossil record furnish real proof of organic descent? How?

No. 2: Mr. E. Furlong, Dept. Geol., Div. Paleo.
What can you say of the origin of the Mustellidae and Procyonidae?
What relation does Phlaocyon bear to Nothocyon?

No. 3: Prof. Chas. A. Kofoid, Dept. of Zool.
What was the most important event in biology in the 19th century?
By whom brought forth. What date?
From what sources was evidence for descent secured? Observation in what particular region supplied Darwin with evidence from geographic distribution?
Now as to the value of the evidence from palaeontology in organic descent cited by you; does not embryology provide more conclusive evidence of descent?
Is not the development of an organism from a single cell significant.
Does not the presence of and manner of development of aortic arches appear to you as more significant than would palaeontological evidence?
Are you certain that the embryology of the horses foot does not show the 4-toed stage that is shown by the fossil forms. (Much more discussion with Kofoid's questions directed to the end of dislodging me from my statement that palaeontology is more reliable than embryology).
What was the second greatest event in biology of the 19th centruy?
What principles or "laws" underlie Mendels findings.
What is dominance? What results from Independent assortment?
Which (genotypes or phenotypes) are important in organic descent?
Does Mendelism provide for origin of new forms?
What is a mutation?
How is sex determined? What other ways? Morgan's latest idea?
Explain Goldschmidt's idea of sex determination.
What is your conception of an atom? What happens to an atom of the higher order such as one of hydrogen when it gives rise to an atom of another sort?
Explain more in detail the compsotion of an atom. How has this affected biological though? In what branches of biology are the effects of this seen today?

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NO. 3, Kofoid, cont'd:

What is a gene? How may another change by m ade in a species besides that of a change in number of chromosomes?

What are the effects of environment?

How account for intersex? How else beside a failure of chromosomes to go to proper half of cell? What may an intersex look like.

What is a free martin? How explained. How are hormones transferred?

What would strike you as most significant if you were presented to a view of all ruminants? What determines this variation in horn structure? Where is it secreted? What is the name ofthe tissue?

What branch of physiology developed within the past ten years especially have changed our ideas of the relations of the parts of the body?

What is the study of these glands called?

From what group did the vertebrates arise?

From what group did the chordates arise? Well then, what groups have been suggested as ancestors?

What other branch of the Arthropods beside Limulus has been suggested? (Discussion of, and few question of detail with regard to the Nemertineans, Annelids, Arthropods, Echinoderm - Balanoglossus stocks)

Who was Lamarck? Ideas of organic descent. (Discussion of, and comparison with certain other workers' ideas, etc.)

Who, until past week, was the most prominent neo-Lamarckian?

Where had he been called just before he committed suicide?

What relation has this (fact that Kammer had been called to teach in Moscow, Russia) to conditions under which Lamarck worked? Under which Darwin worked?

Who was Redi, Aldrovandus, Gesner?

If you were called to the position of head of a biological department what are the first ten periodicals you would select?

As a sequel to Camp's question on phylogenetic significance of ontogeneti features: What is a coenogenetic character? What are some examples?

No. 4: Dr. Chas. Camp, Dept. Zool.

What is teleology? Questions about Paley's works.

What ideas were held by Ray?

Bearing of rudimentary organs, vestigial structure, degenerate forms on teleoelogy. Further discussion of teleology.

Other questions on appearance of embryonic features and phylogenetic significance.

Questions directed to show that aortic arches perhaps have little real phylogenetic value?

No. 5: Prof. Herms, Dept. Entomology.

Are insects found as fossils? Where? What geologic periods? What kinds of insects? What is most primitive insect. How do wings of insect develop? How does grasshopper differ from mosquito? (More questions about wings of ins)

Are any or all mosquitoes carriers of diseases? What ones? What diseases are carried? (What species in Calif.? What sexes?) How are diseases transmitted? Life cycle of malaria. Name of one genus carrying malaria? Name of malaria organism. How control malaria. (Discussion of permanent and temporary methods). How could one eliminate malaria entirely. Do any insects have gills? How does mosquito larva breathe?

No. 6: Prof. Joseph Grinnell. dept. Zool. (Chairman)

No questions.